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THE

JOURNAL OF ECONOMIC BIOLOGY.

EDITORIAL.

IT has for some time been apparent that workers in Economic Biology have found difficulty in obtaining publication of their papers, and particularly so if good illustrations were required.

With the foundation of an Association of Economic Biologists in the United Kingdom, such papers will naturally increase in number, and whilst this body is able to deal with the publication of the smaller papers, larger ones requiring carefully executed plain or coloured lithographic plates are still unprovided for. It is intended in this journal to offer a medium for such work.

No effort or expense will be spared to make it indispensable to all economic biologists, and any suggestions for its improvement will be gladly welcomed and receive careful consideration.

The present Part may be taken as a fair specimen of those to follow, as regards the standard of both the original communications and the illustrations. It is hoped, however, in future numbers to offer critical abstracts of current literature, and to this end authors are invited to forward copies of their publications.

Papers bearing upon any questions in Economic Biology will be welcomed, provided that they represent original work.

The continuance and success of the publication must remain very largely in the hands of an annually increasing body of workers, the growing importance of whose investigations can scarcely be overestimated.

W. E. C.

THE DESTRUCTION OF WOODEN PAVING BLOCKS BY THE FUNGUS LENTINUS LEPIDEUS, Fr.[1]

By

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WITH PLATES I AND II.

WHILST crossing Victoria Square, Birmingham, in the autumn of 1903, I noticed that a considerable number of the wooden paving blocks were becoming rotten. Although the great majority of the blocks were apparently quite sound, one could observe at intervals of a few feet or yards single blocks, or small groups of blocks, which on account of their softness had been beaten down to a lower level than the others, and were evidently in an advanced state of decay (Pl. II, figs. 14 and 17). The bumpiness resulting was noticeable to cyclists and others, while in wet weather puddles collected above places where the rotten blocks were. A similar condition of the pavement was to be seen in a number of the streets of Birmingham, the decay involving many thousands of the blocks.

The paving blocks used in the pavements consist of pinewood, and measure 9 × 6 × 3 inches. They are made from the centre of the tree-trunks. The grain is vertical (Pl. II, fig. 15). Before being laid down the blocks were "pickled," *i.e.*, dipped in creosote. This substance, however, had penetrated into the wood only very superficially. The blocks were placed upon a concrete foundation, and a space of a quarter of an inch in width left between them. Tar was then poured on above until the space was filled to a height of about one inch. The rest of the space between the blocks was afterwards filled with cement grout—a mixture of sand and cement—(Pl. II, figs. 16 and 17). The pavements were made 11 to 14 years ago.

In January of last year the bumpiness of the pavement in many places had become so marked, owing to the increase of the rotten blocks, that repairs had to be undertaken. The rotten blocks were taken up and new ones put in their place. I examined the rotten blocks as they were removed. They were usually split into pieces. The sur-

[1] This paper was written in the autumn of 1904, but owing to my removal to Canada its publication has been delayed.

For a further paper dealing with the reactions of the fruit bodies of the fungus to external stimuli see Annals of Botany, 1905, vol. xix, pp. 427-438, pls. xxiii-xxv.

[Journ. Econ. Biol., 1905, vol. i, No. 1.]

faces so exposed were frequently covered over with a thin white layer of fungus mycelium (Pl. I, figs. 1 and 2). The wood in many cases was so rotten that it could be broken up into tiny fragments with the fingers.

About twenty of the blocks were removed to the laboratory and placed in a large damp chamber having glass sides and top (3 × 2.5 × 2.5 feet). In the course of three weeks some curious conical protuberances, evidently the fruit bodies of a fungus, began to grow out from several of the blocks (Pl. I, figs. 8 and 11). The damp chamber was then removed to a lighter position, and in the course of a few days pilei began to develop (Pl. I, figs. 3, 4, 5, 6, 11, and 12). The fungus was then identified as *Lentinus lepideus*, Fr.

A number of the rotting blocks were obtained in May near the Town Hall. Fruit bodies of *Lentinus lepideus* developed on them also. Altogether I have succeeded in raising the fruit bodies of this fungus on about twenty-five blocks. On some of the extremely rotten blocks no fruit bodies developed at all. The mycelium, although present in these cases also, appeared to be dead.

No other fruit-bodies beside those of *Lentinus lepideus* developed on any of the rotten blocks. At present therefore only one species of fungus has been identified as being concerned in the destruction of the pavement.[1]

In July, I made a visit to a wharf where some thousands of broken blocks, taken from one of the streets of Birmingham, had been placed in a pile some months before. Many of the blocks had been rotted in the manner which is characteristic for *Lentinus lepideus*, and on several I recognized the abortive fruit bodies of the fungus (Pl. I, fig. 9). The conditions for their development as regards moisture and light had evidently been unfavourable.

From the foregoing observations the conclusion seems to me justified that the destruction of a considerable number of paving blocks in the City of Birmingham is being brought about solely by *Lentinus lepideus*.

The principal streets of our large towns are now to large extent paved with wood. The cost of such paving and the inconvenience of repairs are only too well known to the public. The destruction of paving blocks by fungi is, then, not only a matter of scientific interest but also of considerable economic importance. As *Lentinus lepideus* has proved to be an active agent in destroying numerous paving blocks

[1] Since writing the above I have been able to investigate a further set of rotten blocks obtained from another part of the town. The fruit-bodies of a species of *Corticium* developed on them instead of *Lentinus lepideus*. The rot was of a different character to that produced by the latter fungus. My removal from Birmingham has prevented me from proceeding any further with these observations.

in at least one town, it has seemed to me desirable to work out its biology with a view to preventing its ravages. So far as I am aware, the destruction of paving blocks by fungi has hitherto remained uninvestigated. There seems to be no literature on the subject.

Lentinus lepideus is one of the Agaricini. It lives exclusively on wood. Like the Dry Rot Fungus (*Merulius lacrimans*) it appears, at least in the Midlands, to be associated with timber used for building purposes, and is rarely or never to be found in the open. Mr. W. B. Grove, who for more than twenty years has studied the Midland fungus-flora, informs me that he has found *Lentinus lepideus* only on three occasions in this district: once in a cellar in the heart of Birmingham; once in a tanyard, and once in a wooden railway bridge in one of the suburbs. In other parts of the country he has observed the fungus in similar situations, and never in woods. I myself have only found it on the paving blocks. However, Mr. A. Titley has recently brought to my notice a specimen growing in the wood-work of a greenhouse at Sutton Coldfield. The monstrous forms figured in Cooke's Illustrations of the British Fungi were obtained in a brewery cellar at Burton.[1] According to the description in Massee's British Fungus-Flora,[2] however, the fungus occurs "on trunks, stumps, etc." Stevenson[3] states that it grows "on pine," and Cooke[4] on "stumps of firs, etc." Its natural habitat, therefore, appears to be coniferous woods.

The spores are colourless, smooth, and narrowly elliptical (Pl. II, fig. 18). They measure 10—8μ × 4·5—3μ. Germination was observed in hanging-drop cultures. In distilled water or tap-water the spores remain unchanged, but germinate readily in Pasteur's Fluid or in beef-gelatine. They also germinate in decoctions of pine-wood and of horse-dung. Owing to the deposition of horse-dung in our streets the conditions for spore-germination upon the paving blocks in rainy weather would seem to be well provided.

In Pasteur's Fluid the spores germinate within 24 hours. As a rule germ-tubes are put out successively at both ends of the spore, and but very exceptionally at the side (Pl. II, fig. 19). The germ-tubes soon become almost as thick as the spores. After a few days' growth it is difficult or impossible to distinguish the position of the spore in the mycelium (Pl. II, fig. 20). The germ-tubes branch and the lateral branches grow relatively far before rebranching. The appearance of the mycelium after two and a half days is shown in fig. 20, and after five days in fig. 21.

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[1] M. C. Cooke, Illustrations of British Fungi, pl. 1141.
[2] G. Massee, British Fungus-Flora, vol. ii, p. 313.
[3] J. Stevenson, Mycologia Scotica, 1879, p. 120.
[4] M. C. Cooke, Handbook of British Fungi, 2nd ed., p. 355.

A similar development took place in beef-gelatine (Pl. II, figs. 22 and 23). Plate and tube cultures were made. The mycelium grew slowly. Each spore gave rise to a plant about 12 millim. across in the course of a month. No signs of the mycelium breaking up into oidia or of their producing conidia could be observed.

The mycelium occurs in abundance in the cells of the rotting wood (Pl. II, fig. 24). The hyphae branch occasionally, and are provided with clamp connections (*c.*). Frequently the hyphae become coated with crystals of calcium oxalate (*o.*). In some cases a trail of crystals could be observed, although the hypha from which the salt had been excreted was not to be discovered, and seemed to have disappeared (*t.*). Similar trails of crystals were observed by Robert Hartig [1] when investigating the destruction of wood by *Merulius lacrimans*.

The hyphae in passing from tracheide to tracheide sometimes make their way through the cell-walls at the bordered pits (*p.*). Frequently, however, holes are made by the hyphae in walls where there are no pits (*h.*). Such holes become larger than the diameter of the hyphae. In this respect *Lentinus lepideus* differs from *Merulius lacrimans*.[2]

Macroscopically the very rotten wood resembles that rotted by *Merulius lacrimans*. This is doubtless the explanation of the statement, made to me by some workmen, who had had much experience in repairing work, that the pavement suffered from Dry Rot. The wood becomes red. When wet it is very spongy, so that it quickly soaks up water, which can be squeezed out again with the hand. A pencil is easily poked through the wood. Upon drying it shrinks very considerably, and cracks both longitudinally and transversely (Pl. I, fig. 10). It also becomes so extremely brittle that one can powder it up into the finest fragments with the fingers. The thin coating of mycelium, which one sees on breaking open a block freshly obtained from the street, is formed in the spaces left by the cracking of the wood during shrinkage (Pl. I, figs 1 and 2).

Examined with the microscope the tracheides, except for holes made in them by fungus hyphae, appear to be left intact (Pl. II, fig. 24). The middle lamella is not destroyed, so that the cells do not separate from one another. The secondary thickening appears to have undergone no change. Wood cells acted on by *Merulius lacrimans* present similar characters.[3] The medullary ray cells are devoid of starch grains, but often contain contents (*ptp.*) which resemble protoplasm in appearance.

The rotten wood is much lighter than the sound. It is quite

[1] R. Hartig, Der ächte Hausschwamm, Berlin, 1885, p. 12; also Taf. 1, fig. 2.
[2] R. Hartig, *loc. cit.*, p. 11.
[3] R. Hartig, *loc. cit.*

evident, therefore, that a considerable amount of substance has been removed by the fungus from the cell-walls.

On testing for hadromal[1] with phloroglucin and hydrochloric acid, every tracheide in the most rotten wood was found to turn a bright red. Some rotten wood was then ground up to a fine powder and left to soak in cold water for several days. The filtered extract did not show the phloroglucin reaction. Some of the powder was then placed in 90 per cent. alcohol for an hour. At the end of that time the filtered extract gave a bright red colour with the phloroglucin test. In the course of 24 hours' extraction with the alcohol the extract became yellowish in colour, and then gave an intense red reaction with phloroglucin and hydrochloric acid. If the phloroglucin test is to be relied upon, it seems, therefore, that hadromal is left behind in considerable quantities in the cell-walls. Hadromal is also left behind in wood rotted by *Merulius lacrimans*.[2]

The fresh pine-wood turns green with phenol and hydrochloric acid, and yellow with analine sulphate and sulphuric acid. As the wood becomes rotten it ceases to give these reactions. The alcoholic extract of the rotten wood also gives negative results. Wood acted upon by *Merulius lacrimans* similarly ceases to give the phenol reaction.[3]

The most rotten wood was then treated with Schulze's maceration fluid. The wood dissolved away rapidly. The fragments left were tested with chlor-zinc iodine. Here and there a few fragments of cell-walls stained blue. It became evident, however, by comparison with sound wood, which had been macerated in a similar manner, that the very rotten wood contains scarcely more than a trace of cellulose. *Merulius lacrimans* also removes the cellulose from the wood.[4]

Lentinus lepideus and *Merulius lacrimans* act upon coniferous wood not only physically but also chemically in a very similar manner. Both fungi destroy the cellulose and leave behind a red friable substance, which contains hadromal.

The fruit-bodies of *Lentinus lepideus* as a rule have no chance of developing in the streets, owing to the traffic above the pavement and want of space below it or between the blocks. However, they readily developed when rotten blocks were placed in a damp-chamber in a well lighted position. About 14 days after the rotten blocks were obtained from the street a snow-white mycelial covering grew out upon the surface of the blocks, especially on surfaces exposed by breaking

[1] Czapek. Zur Biologie der holzbewohnenden Pilze. Ber. d. D. Bot. Gesell., 1899, Bd. 17, pp. 166-170.

[2] R. Hartig, *loc. cit.*, p. 53; and Czapek, *loc. cit.*

[3] R. Hartig, *loc. cit.*, p. 53.

[4] R. Hartig, *loc. cit.*, p. 54.

(Pl. I, figs. 6 and 8). About two days afterwards a number of small white papillae—the beginnings of the fruit-bodies—began to develop on the mycelium.

The papillae often arise in considerable numbers side by side. They develop into conical protuberances, at first quite devoid of pilei (Pl. I, figs. 8 and 11). In two instances similar conical protuberances were actually found on some paving blocks as they were removed from Victoria Square. They had formed in crevasses, between the blocks in one case, and below in the other.

A pileus forms on the end of each conical protuberance (Pl. I, fig. 11). Massee, in describing the fungus, mentions a "veil very soon disappearing."[1] In my specimens no trace of a veil could be seen. The pileus is gymnocarpous from the beginning. The gills are never hidden in a gill chamber. Stages in the formation of a fruit-body are shown in figs. 11 and 25. As the pileus grows larger decurrent gills are formed, which develop torn edges as in all the species of *Lentinus* (Pl. I, fig. 3). The mature fruit-bodies are very variable in shape, the variations depending largely on external conditions, especially light (*cf.* figs. 3, 4, and 7). The reactions of the fruit-bodies to external conditions are, however, treated of in another paper.[2]

The hymenial layer upon the gills contains basidia and paraphyses (Pl. II, figs. 26 and 27 *b.* and *p.*). The former bear four sterigmata (*st.*) which give rise to the four spores (*s.*). The paraphyses (*p.*) are very similar to the basidia but are not so broad at the ends. Cystidia are absent.

The colourless spores are shed in vast numbers. A full-sized pileus probably produces several million of them. As is the case with most Agaricini, the spores are scattered by the wind which doubtless can carry them long distances without injury.

The chief factor in the destruction of paving blocks made of pine-wood seems to be mechanical erosion. The blocks get worn down in Birmingham in busy streets at the rate of a quarter of an inch per annum. Some blocks in my possession were originally 6 inches thick. In the course of about fourteen years they were reduced to 2.5 inches in thickness (Pl. I, fig. 13). When they were removed at the end of that period they were quite sound, and unattacked by fungi. Mechanical erosion causes the blocks to wear out fairly evenly. *Lentinus lepideus*, by rotting particular blocks, shortens their period of usefulness and causes holes and bumpiness in the pavement. The fungus, therefore, by its action necessitates a large number of repairs which would not have to be undertaken if mere wear and tear of street traffic were the only factors in the destruction of the blocks.

[1] G. Massee, British Fungus-Flora, vol. ii, p. 313.

[2] *Loc. cit.*

When the blocks are laid down they have been already dipped in creosote, and are taken to the streets in a fairly dry condition. It seems probable that the blocks at that time are not yet infected with *Lentinus lepideus*. For several years after they have been laid down the blocks appear to remain quite sound. Then some of them begin to go rotten. As the pavement gets older more and more blocks decay, until in the course of something like ten years some thousand may be affected and periodic repairs have to be undertaken. Infection may well take place in some cases from spores which fall into cracks in the wood. I have noticed cracks in some blocks in great numbers on hot days. The creosote only makes its way into the wood to a depth of between one-eighth and one inch, so that cracks would not have to be very deep for spores to fall below the creosoted part.

In the course of a few years the upper creosoted layer of the pavements becomes worn off by the traffic. Small pebbles, sand, etc., get pressed into the blocks above. Except where these obstacles act as a hindrance, spores can come in direct contact with the uncreosoted wood. It seems to me probable that the obstacles mentioned afford a good deal of protection against infection by means of fungus spores.

Whence come the spores? It has been observed that the fruit-bodies of the fungus occur on timber associated with buildings, and are to be found in cellars, on wooden bridges, in wood-yards, etc. All sorts of wood-work are constantly being carried through the town. Spores may be blown from rotten wood-work removed during repairs, whilst it is being carried through the streets. The wind may bring spores directly from the various places, perhaps including pine and fir woods, where the fruit-bodies come to maturity. Possibly spores are contained in the horse-dung. To account for the infection of so many blocks in so many streets one must suppose that the spores are plentifully scattered over the pavement.

Since, as already mentioned, the spores germinate in various nutrient media, including decoctions of pine-wood and of horse-dung, they probably germinate readily enough in contact with the wood in wet weather. The mycelium probably grows in a block for some years before the latter is thoroughly rotted. Infected blocks usually become rotten at one end or on one side first (Pl. II, fig. 14 *a. b.*). The decay then gradually spreads over the whole block. The reduction in the specific gravity of the blocks, one may perhaps suggest, is chiefly due to the carbohydrates in the cell-walls being ultimately split up into water and carbon dioxide during the respiration of the fungus.

Although the mycelium grows luxuriantly in the pavement, no fruit-bodies are formed, for mechanical reasons, as already mentioned. There is, therefore, no reason to suppose that a rotten block by means of spores can infect other sound blocks not adjacent to it. The ques-

tion, however, arises as to whether a rotten block may affect its immediate neighbour by means of its mycelium. In many cases single blocks are found to be quite rotten, and the adjacent ones quite sound. Here one must conclude that, although the mycelium has been growing in the rotten block for a long period of time, probably years, owing to the perfect insulation of the rotten block by the tar, cement grout and creosote (Pl. II, fig. 17), infection of the neighbouring sound blocks has been prevented. On the other hand one frequently finds small groups of two, three, or more rotten blocks together. In such cases, *e.g.*, at *e*, *f*, *g*, and *h*, in figure 14, it seems fairly certain that local mycelial infection has taken place. That one rotten block infects its neighbour in the course of time is also a view held by several workmen, very experienced in road repairing, of whom I made enquiries. In some instances, as rotten blocks were being taken up, I actually saw the mycelium growing beneath the blocks over the creosoted surface. Any fault in the laying or wearing of the blocks might easily lead to the infection of neighbouring blocks.

The constant watering of the streets is probably an important factor in maintaining the existence of the fungus in the blocks. When a block has begun to rot it soon gets beaten down to a lower level than the sound blocks. In consequence of the presence of a single rotten block a shallow depression, involving the adjacent sound blocks, is made by the traffic (Pl. II, fig. 17), and a puddle is formed whenever rain falls or the street is watered. The water is rapidly soaked up by the rotting wood. The blocks, therefore, rarely have a chance to dry, and the fungus escapes desiccation accordingly. Whether desiccation kills the mycelium is a question which I have not yet succeeded in answering.

Several persons engaged in the road repairing have informed me that, the less a street is used, the more it suffers from rotting of the blocks. The worst infected street known to me is very little used. Assuming that traffic is inimical to infection of the blocks by the fungus, the explanation of the fact does not seem very clear.

Judging from the numbers of repairs that are constantly being made on account of the ravages of *Lentinus lepideus* or other wood-destroying fungi, the cost of treating the blocks with an antiseptic, with a view to preventing the growth of the fungus, is well worth considering. I found that the thin outer layer of wood, which has been impregnated with creosote in a dipped block, often remained quite sound, when the rest of the wood had become quite rotten. This fact and also results obtained with railway sleepers [1], clearly indicate that *Lentinus lepideus* or any other wood-destroying fungus could be kept out of

[1] Hermann von Schrenk, The Decay of Timber and Methods of Preventing it. Washington, 1902, pp. 49-51.

paving blocks by fully impregnating the latter with creosote. Already fully creosoted blocks are being made in large numbers for the pavement of towns, but are by no means universally used. A large number, amounting to hundreds of thousands, are shortly to be laid down in Birmingham.

On enquiring of a road surveyor what advantage the fully creosoted blocks have over the dipped blocks, the answer was that the creosote keeps out the water and thus prevents decay. The creosote, however, as my investigations show, must act by keeping the blocks free from wood-destroying fungi. Possibly a cheaper treatment than creosoting might be devised for this purpose.

The extra cost of fully creosoted blocks, over those which are merely dipped in creosote, is considerable. Blocks are now supplied into which 8, 12 or 16 lbs. of creosote have been compressed per cubic foot. When only 8 lbs. of creosote have been pressed in per cubic foot, according to a calculation kindly communicated to me by Mr. John Price, the Surveyor for the City of Birmingham, about 15 per cent. is added to the cost of the pavement. Whether the saving in repairs, owing to use of such blocks, would more than compensate for the extra initial cost of the latter is a question which must be left to surveyors, engineers, and others, whose business it is to lay down pavements, with due regard to economy and the public convenience.

These investigations were carried out at the University of Birmingham, and I have much pleasure in expressing my best thanks to Professor Hillhouse for allowing me the use of the photographic and other resources of the Botanical Laboratory.

SUMMARY.

1. The destruction of a large number of paving blocks, made of pine-wood, in the City of Birmingham, is being brought about by *Lentinus lepideus*, a fungus belonging to the Agaricini. Considerable repairs to the pavement are thereby necessitated.

2. Single blocks, or small groups of blocks at intervals in the streets go completely rotten, so that one can break up the wood with the fingers. The streets affected become unduly bumpy. In wet weather puddles collect above places where rotten blocks are.

3. A number of rotting blocks, obtained from time to time from the streets, were placed in a large damp-chamber. In the course of a few weeks fruit-bodies of *Lentinus lepideus* appeared upon them.

4. The spores remain unchanged in distilled water and tap-water, but germinate readily in Pasteur's Fluid and in beef-gelatine. They also germinate in decoctions of horse-dung and of pine-wood.

5. The pavement is probably infected by spores after the blocks

have been laid down. The mycelium often grows from a rotten block to the neighbouring sound ones. No fruit-bodies are produced in the streets owing to the traffic.

6. The wood is rotted by *Lentinus lepideus* in very much the same manner as by *Merulius lacrimans* (the Dry Rot fungus). It becomes red, and is spongy when wet. It shrinks and cracks considerably on drying, and is then very brittle and friable. Cellulose is removed from the cell-walls and hadromal left behind.

7. The paving blocks, used in the pavements referred to, were dipped in creosote before use. Had they been fully impregnated with that substance, the ravages of *Lentinus lepideus* or any other wood-destroying fungus would have been prevented.

EXPLANATION OF PLATES I AND II.

Illustrating Professor Buller's paper on "The Destruction of Wooden Paving Blocks by the Fungus *Lentinus lepideus*, Fr."

PLATE I.

Figs. 1 & 2.—Mag. $\frac{1}{4}$. Rotten blocks of Pine just removed from a street pavement. The white mycelium of *Lentinus lepideus* is seen on the surfaces exposed by breaking the blocks.

Fig. 3.—Nat. size. Fruit-body of *Lentinus lepideus* growing out of a paving block. The gills are broad, decurrent, and have torn edges. Two drops have been excreted by the gills.

Fig. 4.—Nat. size. Another fruit-body of *Lentinus lepideus*. The stipe is long. The pileus is chiefly developed on the side toward the observer.

Fig. 5.—Mag. $\frac{1}{4}$. The paving block upon which grew the fruit-body of fig. 4.

Fig. 6.—Mag. $\frac{1}{4}$. The paving block upon which grew the fruit-body of fig. 3.

Fig. 7.—Nat. size. A fruit-body. The gills are equally developed all round the pileus.

Fig. 8.—Mag. $\frac{3}{8}$. Paving block upon which monstrous fruit-bodies have developed in the dark. A white mycelial covering is to be seen upon the wood surface. The covering produced papillæ which grew into the conical protuberances and rods. There are no pilei.

Fig. 9.—Mag. $\frac{5}{12}$. Paving block found among a pile of blocks which had been removed from a street in Birmingham. To the left is a monstrous fruit-body of *Lentinus lepideus*. It is branched like an elk's horn and is without a pileus.

Fig. 10.—Mag. $\frac{3}{5}$. Paving block rotted by the fungus and then allowed to dry. Transverse and longitudinal cracks have formed in the wood owing to shrinkage.

Fig. 11.—Nat. size. Three young fruit-bodies grown in moderate light. The uppermost one is aborted, and has ceased its development. The lowest one still shows no signs of a pileus. The middle one is producing a pileus, upon which drops of water have been excreted. The whole group is photographed from below. The middle fruit-body developed into that in fig. 7.

Fig. 12.—Mag. $\frac{1}{6}$. In the centre a paving block from which developed the fruit-body of fig. 7. To the left, a block producing several young fruit-bodies with rudimentary pilei.

Fig. 13.—Mag. $\frac{1}{6}$. In the centre is a new paving block which measured 6 inches in height. To the right and left are two blocks, originally of the same height as the centre block. During about 14 years, whilst forming part of the pavement in Broad Street, Birmingham, $3\frac{1}{2}$ inches of wood were worn off them by mechanical erosion. The wood remaining was quite sound.

Plate II.

Fig. 14.—Mag. $\frac{1}{18}$. Diagram of pavement to illustrate occurrence of rotten blocks. At *a*, *b*, and *c*, blocks are beginning to decay. The blocks *d.d.* are quite rotten, but have not infected their neighbours. At *e*, *f*, and *g*, groups of rotten blocks are seen. At *h* are two quite rotten blocks, the block between being rotten only at the ends in contact with the rotten blocks.

Fig. 15.—Mag. $\frac{1}{6}$. The top, *a*, and side, *b*, of a typical paving block, showing the direction of the grain.

Fig. 16.—Mag. $\frac{1}{6}$. A whole block on the left, and part of a block on the right, showing how the blocks are packed. The space between the blocks is filled up with tar, *t*, and cement grout, *c*.

Fig. 17.—Mag. $\frac{1}{6}$. A rotten block, *r*, in the centre, and two sound blocks, *s.s*, right and left. The depression in the pavement involves the edges of the sound blocks. A puddle forms in the depression in wet weather; *c*, cement grout; *t*, tar.

Fig. 18.—Mag. 600. Spores of *Lentinus lepideus*.

Fig. 19.—Mag. 600. Germinating spores after 23 hours in Pasteur's Fluid.

Fig. 20.—Mag. 600. Germ-tubes 54 hours after the spores were placed in Pasteur's Fluid; *s.s*, the position of the spores.

Fig. 21.—Mag. 160. Two young plants 5 days after the spores were placed in Pasteur's Fluid.

Fig. 22.—Mag. 160. Development of mycelium from a spore during 5 days in beef-gelatine.

Fig. 23.—Mag. 160. Development during 8 days in beef-gelatine.

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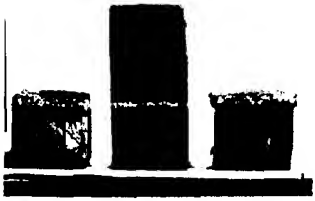

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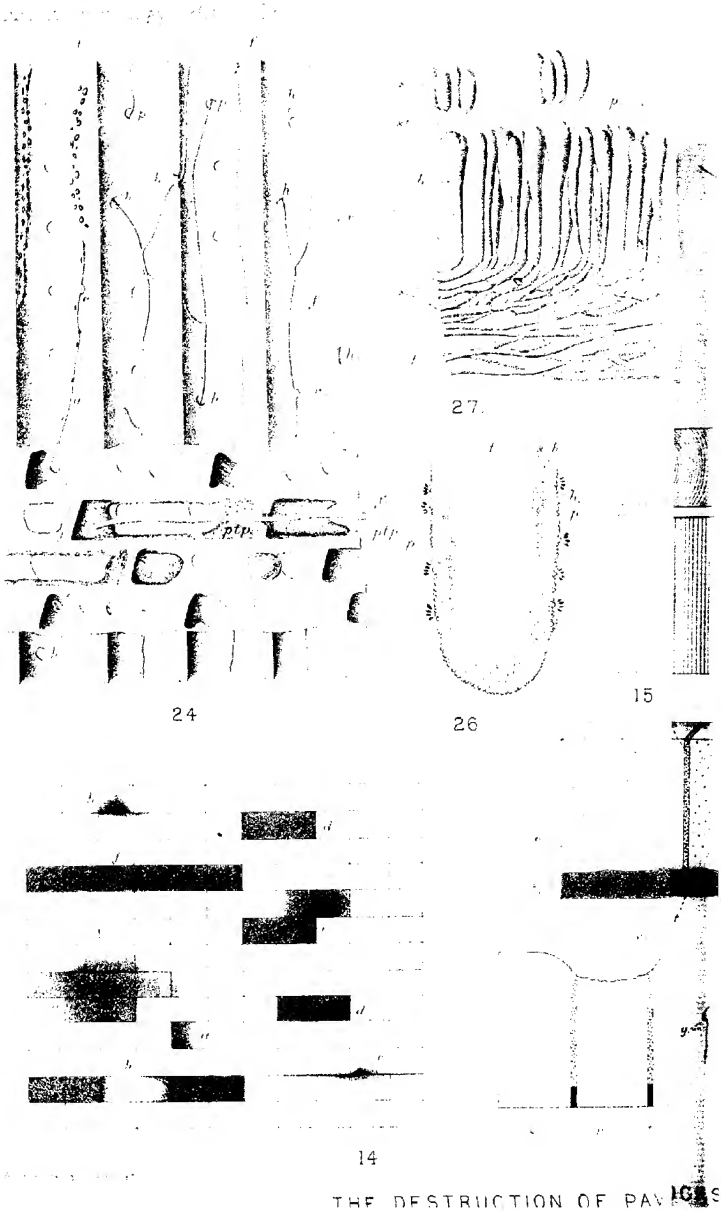
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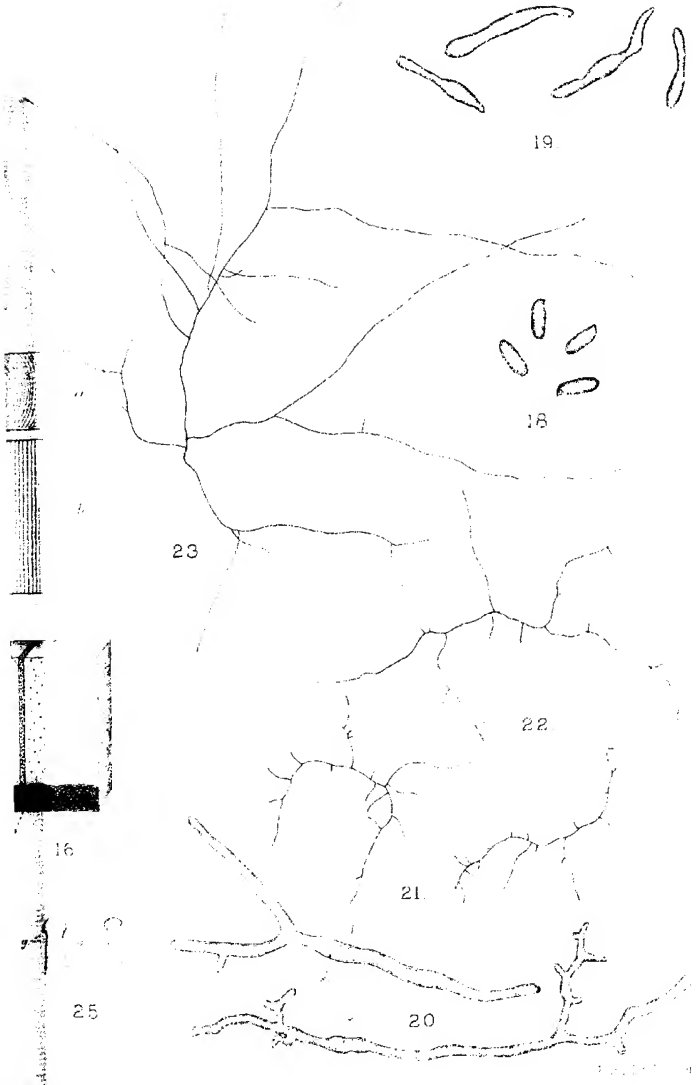


S BY LENTINUS LEPIDEUS. Fr

Fig. 24.—Mag. 450. Radial-longitudinal section of wood of Pine from a rotten paving block. A medullary ray is represented crossing four tracheides. The hyphae, *f.f*, of *Lentinus lepideus* are to be seen in the cell lumina. The hyphae are sometimes branched, and are provided with clamp connections, *c.c*. The hyphae make their way from cell to cell through bordered pits, *p.p*, or bore holes through the walls, *h.h*. Some hyphae are coated with crystals of calcium oxalate, *o.o*. At *t*, the hyphae has disappeared, and a trail of crystals have been left behind. Cell contents looking like protoplasm, *ptp*, are left behind in some of the medullary ray cells.

Fig. 25.—Nat. size. Very young fruit-bodies. The pileus is just beginning to be formed. It is gymnocarpous, *g.g*, the rudimentary gills not enclosed in a gill-chamber.

Fig. 26.—Mag. about 85. A semi-diagrammatic section through one of the gills of *Lentinus lepideus*. The hymenium, *h*, contains paraphyses, *p*, and basidia, *b*. Each basidium produces four sterigmata and four spores; *s*, sub-hymenium; *t*, the trama.

Fig. 27.— Mag. 600. Section through the hymenial surface of a gill; *t*, the trama; *s*, the sub-hymenium; *h*, the hymenium; *b*, basidium; *st*, sterigmata; *s*, spore; *y*, young basidium with four rudimentary spores; *p*, paraphyses.

THE EFFECT OF CHANGE OF FOOD AND TEMPERATURE ON THE DEVELOPMENT OF ABRAXAS GROSSULARIATA, STEPH.

By

WALTER E. COLLINGE, M.Sc.,

The University, Birmingham.

With Figures 1-5.

During the summer of 1904, I bred for various purposes, large series of the common Currant or Magpie Moth, *Abraxas grossulariata*, Steph. The apparatus used consisted of a series of wide-mouthed 4 lb. glass jars, with a little sand at the bottom of each, the mouths being covered with pieces of fine netting secured by elastic bands. These jars I shall refer to as A to H.

Into these, leaves of the black currant with young larvae on were placed, and supplied with fresh currant leaves daily. The jars A to E were arranged on an outside window ledge.

Towards the end of the season most of my currant trees had become stripped of their leaves, and so the last two lots of larvae were supplied with lettuce leaves, which they took to only as a last resort, practically when starving. These two jars, F and G, were kept in a fairly warm room, and the larvae presented all the features characteristic of the species.

As, I believe, the results of the change of food, and possibly temperature also, the following variations were noticed. The larvae pupated in jar F at least ten days, and in jar G eight days, earlier than those which had been kept in the jars A—E outside. The pupae were considerably smaller, and the imagines which appeared after fourteen days were nearly all, twenty-three in number, yellowish-white, with only very few and faint chocolate markings; further, without exception, all the twenty-three specimens were considerably smaller. Two of the females from jar F were paired with typical males, and as a result one deposited on June 27th 163 eggs, which hatched out on July 12th; these were in a glass jar, which we will term H, and fed on lettuce for some three weeks, when, going away I had to leave them. On my return, however, I noticed that many had spun themselves up in the

[Journ. Econ. Biol., 1905, vol. i, No. 1.]

leaves or were sheltering beneath bits of half-eaten leaves, which they had fastened together, on the floor of the jar.

Early in the present year seventeen of the larvae commenced to feed upon lettuce leaves. They evidently did not relish this fare, and remained undersized and sickly-looking individuals. Eight pupated on May 20th, the remainder dying. The eight pupae measured 10.5 millim. in length. Of these, five developed, and the moths produced differed materially as regards size, colour, and markings from the typical form. There was very little yellow on any of them, two had

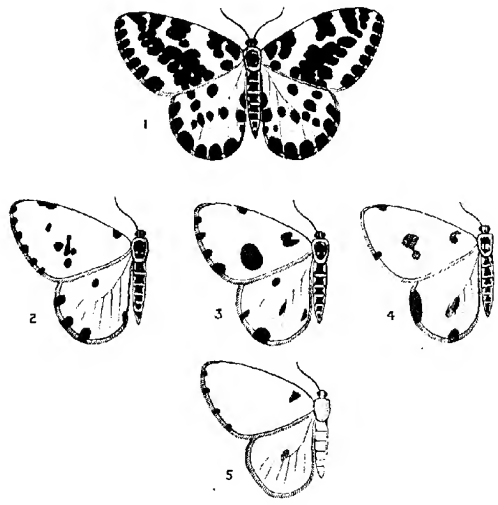


Fig. 1.—Typical example of *Abraxas grossulariata*, Steph. × 1.
Figs. 2-5.—Variations of the same. × 1.

a few brownish markings, as shown in figure 2; one was almost white, with markings, as shown in figure 3; another had markings, as shown in figure 4; while the fifth was perfectly white, with very faint markings, as shown in figure 5.

All the five specimens were practically of the same dimensions, numbers 1-4 measuring 46.5 millim., and number 5, 45 across from tip to tip of the fore wings, and 23.5 millim. from the anterior border of the fore wing to the posterior extremity of the hind wing.

Under natural conditions the average duration of the different phases of their life-history is as follows: The larvae hatch out of the

egg in eleven or twelve days, and on the approach of winter they spin the leaves together and enclose themselves and fall to the ground; they may also hibernate in the cracks and crevices in walls, or in the accumulations of dead leaves between the branches and the wall. In the early spring they commence to feed upon the young leaves, and usually become full fed about June. The larval stage may be short or long, the period varying according to the supply and nature of the food, temperature, etc.

The pupal stage occupies from ten to twenty days, and of the sixty-three pupae measured from various localities the average size was 13.5 millim., the difference between the minimum and maximum was about one millim.

The imagines measured as follows:—

Jar A.—Twenty-two specimens,	average	48.5	millim.
Jar B.—Thirty-one specimens,	„	49.5	„
Jar C.—Sixteen specimens,	„	49	„
Jar D.—Twelve specimens,	„	50	„
Jar E.—Twenty-eight specimens,	„	49.5	„

The results obtained from these experiments are not, I think, without interest, for they indicate that whilst this insect is capable of living upon lettuce, that plant certainly lacks something that is necessary to the perfect development, and I think that it is very probable that it would not be possible to carry the experiment to a third generation, unless the specimens in Jar II were paired with normal individuals.

I hope to have an opportunity of trying further experiments at a later date; in the meantime I should be glad to learn of anyone who has conducted similar ones and the results obtained, or of any which may be tried in the future.

NEW CULICIDAE FROM INDIA, AFRICA, BRITISH GUIANA, AND AUSTRALIA.

By

FRED. V. THEOBALD, M.A.

With Plates III. and IV.

WHILST recently examining some of the collections of mosquitoes constantly being received from abroad I have found at least a hundred new species and some dozen new genera. Several from India (exclusive of Ceylon), Africa, British Guiana, and Australia are described here.

The number of species of *Culicidae* is rapidly increasing, some one hundred odd species have been described since the publication of my last volume of the Monograph of *Culicidae* of the World, and I have probably between one hundred and fifty to two hundred waiting to be described amongst the material I now have on hand. Dr. Leicester is describing a number of new genera and species from the Federated Malay States in addition to those of his I have described in the *Entomologist* for 1904 and 1905. By far the greatest number of new forms I have come from South America and Africa. The former I am waiting to describe in conjunction with Dr. Lutz, of São Paulo, who has already added new species to the Brazilian fauna and much valuable information concerning them, as a separate work, as the indigenous *Culicidae* of South America are so peculiar and so very different from those of the rest of the world.

Three new genera and thirteen new species, and the previously unknown male of *Culex similis*, Theob., are described in this paper.

A species in Felt's genus *Culicada* is described, and I have added some generic peculiarities by which the genus can be identified by more general characters than those given by Felt.

Genus **Pyretophorus**, Blanchard.

= *Howardina*, Theobald: Mono. Culicid., 1902, iii, p. 66.

Pyretophorus ardensis, n. sp.

Pl. III, fig. 3.

Head deep brown with grey scales; palpi in female brown with white apex and three other narrow white bands; proboscis brown. Thorax grey in the middle, dark brown laterally. Abdomen dark

brown with golden hairs. Legs brown with femora, tibiae and metatarsi spotted, tarsi with narrow apical pale bands, with yellow and deep brown scales, costa with six black spots, the two apical spreading evenly on to the first long vein, the third large having a large and small dark area beneath it, the fourth smaller, the two basal ones very small and only on the costa; fringe spotted.

Female. Head deep brown, clothed a few white narrow-curved scales in the middle, numerous large white upright forked scales at the sides of them, and then upright black forked scales, two tufts of small white scales project forwards between the eyes, and some longer grey median scales between them. Palpi brown with deep brown scales, apex broadly white and with three other narrow white bands, one close to the broad apical fascia; proboscis deep brown, a little longer than the palpi. Antennae deep brown, basal lobe nude, second segment with a few grey scales. Thorax slaty grey in the middle, with a median dark line and traces of lateral dark lines on it, at the sides it is deep rich brown, clothed with long narrow-curved golden hairs and a tuft of white scales in front projecting over the head; at the sides of these appear dusky outstanding spatulate scales, which may be attached to the prothoracic lobes; scutellum slaty grey (ochreous in some lights) with a few long golden curved hairs and long brown posterior border-bristles; metanotum deep brown. Abdomen deep blackish-brown, shiny, with long golden-brown hairs.

Legs deep brown, banded and spotted with pale creamy white as follows: A narrow apical band at the apex of the first and second fore tarsals, also at the apex of the metatarsal, which has also two broad and two narrow bands upon it, tibiae and femora with white spots, the two apical tarsi are pure brown; in the mid legs the tarsi are the same, but the metatarsus is more spotted and the femora less so, having only five instead of six spots; in the hind legs the metatarsus has seven equi-distant and prominent spots, whilst the first three tarsi have the apex with a pale band, claws equal and simple; coxae pallid. Wings with yellow and black scales; on the costa are six black areas, the apical one smaller than the second, the second than the third, the fourth about equal to the apical one in size; the two basal ones over small, the first and second extend evenly on to the first long vein, the third is broken on the first long vein near the base (as in *P. costalis*), the fourth extends evenly on to the subcostal and first, the two basal ones do not extend below, the branches of the second vein are dark scaled except at their apices and at the commencement of the fork, two dusky spots on the stem, one beneath the large costal spot (3rd). The third long vein has three black areas, one apical, a large and small one near the base; two black spots on each branch of the fourth, stem all black but for two small yellow spots; the fifth is all

yellow except a black spot at the base and apex and three black spots on the upper branch; the sixth has three black spots; fringe brown, with a yellow spot where each vein joins the costa except the sixth. Halteres pallid with slightly fuscous knob with small grey scales.

Length, 5 to 5.5 millim.

Male.—Palpi with the two apical segments swollen, of about equal size, clothed with white scales at their apices, brown elsewhere, the antepenultimate segment has also a small white apex and a small white spot on one side towards the base, two apical segments and apex of the antepenultimate with long golden-brown hair-tufts; antennae yellowish-grey, with deep brown verticillate hair, giving a banded appearance; legs and wings much as in the female, but one less spot on the hind metatarsi; fore ungues very unequal, the larger curved and uniserrate; mid apparently small and simple; hind small, equal and simple.

Length, 5.5 millim.

Hab.—Natal (Dr. Power).

Described from a perfect male and female. The ornamentation of the legs is very marked. The specimens were taken in Durban, where malaria was prevalent at the time, and the female had fed from a patient suffering from that disease (malignant tertian).

It will probably prove to be a malaria carrier with *P. costalis*, Loew.

Genus **Stegomyia**, Theobald.

Mono. Culicid., 1901, i, p. 283.

Stegomyia poweri, n. sp.

Pl. III, fig. 2.

Head velvety black with median and lateral white patches; palpi black with snowy white apices; proboscis black. Thorax blackish brown with a median yellowish-white line, a silvery patch on each side in front of the wings extending as a fine yellowish line towards the scutellum, and a silvery patch on each side of the wings. Abdomen blackish-brown with basal white bands and large white basal lateral spots. Legs black and banded with white, base of hind femora white; fore legs with basal white bands to metatarsus and first tarsus, mid legs the same, but the first tarsus nearly all white, hind legs with the third tarsus all white, the fourth black.

Female.—Head clothed with flat violet black scales, with a double row of median silvery white ones and a small patch on each side and a few white scales around the border of the eyes, bristles jet black; palpi black, scaled with snowy white scales apically, and a few forming a narrow band towards their middle; antennae deep brown with

narrow white pale bands and deep brown verticillate hairs, basal segment black basally; with grey tomentum apically and a few white scales on the inner side; proboscis jet black.

Thorax deep brownish-black with reddish-brown narrow-curved scales, ornamented as follows:—A median yellow line of narrow curved scales extending from a small white spot near the head to the bare space in front of the scutellum, a patch of silvery white broader scales on each side towards the front, from which proceeds a whitish-yellow line running parallel to the median one on each side passing down to the scutellum and composed of broader curved scales than the rest, there is also a smaller silvery white spot just before the base of each wing, bristles deep brown; all the scales slope uniformly backwards; scutellum deep blackish-brown with flat silvery white scales and deep brown border-bristles; metanotum deep brown; pleurae deep brown with silvery white puncta, three forming a line anteriorly. Abdomen deep blackish-brown, the first and second segments unbanded, the former with long pale golden-brown bristles, the third to sixth segments with basal white bands somewhat indented in the middle and not extending completely across the abdomen, the seventh segment with a few plain scales in the middle basally placed, all the segments with large basal snowy-white patches, border-bristles short, bright brown to golden. Legs black, with the base of the fore tibiae, metatarsi and first tarsus white; in the mid legs there is a white spot at the apex of the femora, and a prominent round white spot on the middle of the segment, a white basal band to the metatarsus, and the greater part of the first tarsus white, and traces of a few white scales at the base of the second tarsus; in the hind legs the femora are white at the base, and have a small white apical spot, white basal bands to the metatarsus and first two tarsi, the third is pure white, the fourth black; ungues of fore and hind legs uniserrated, of hind equal and simple. Wings with dense brown scales; first sub-marginal cell considerably longer and narrower than the second posterior cell, its base considerably nearer the base of the wing than that of the second posterior cell, its stem less than one-half the length of the cell; stem of the second posterior cell as long as the cell; posterior cross-vein nearly three times its own length distant from the mid. Halteres thick, with ochreous stem and fuscous knob.

Length, 5 millim.

Hab.—Natal (Dr. Power).

Described from a perfect female. It is a very distinct species, easily told by the single median yellow thoracic line and legs from *S. scutellaris* (Walker), and by the single, not double line, seen in *S. simpsoni*, as well as by the legs. It is a very handsome species, and so far nothing like it has occurred outside Natal. Probably it will be

found in the Transvaal and other neighbouring regions. Apparently closely related to *Stegomyia gardneri* (Ludlow), from the Phillippine Islands, but easily separated by the large anterior silvery white thoracic spot and by the ornamentation of the hind tarsi.

Genus **Gnophodeomyia,** nov. gen.

Head clothed with flat scales, rounded apically, with a band of a few narrow-curved scales behind and numerous upright forked scales. Palpi of female rather short, the penultimate segment longer than the basal ones, apical segment minute, mamilliform. Thorax with very narrow curved scales, also the scutellum; metanotum nude. Wings with normal venation, the scales on the apical area dense and large. Male unknown.

This genus comes near *Danielsia*, Theob. (The Entomologist, 1904, p. 78), but differs in the head scales being more uniform in arrangement, rounded apically, not truncated, and also in the scales of the wing.

Gnophodeomyia inornata, n. sp.

Pl. IV, fig. 8.

Head brown in some lights, greyish in others, palpi and proboscis brown. Thorax light brown, unadorned; pleurae reddish to dull brown. Abdomen deep blackish-brown with small basal lateral white spots. Legs deep brown; coxae, base and venter of femora reddish-brown. Wings with brown scales, not quite reaching to the apex of the body. Ungues small, equal and simple in the female.

Female.—Head deep brown, clothed with flat scales with rounded apices, which are dull brownish-grey in some lights, violet-brown in others; behind, forming a band partly across the nape; are narrow curved pale golden scales, and there are also numerous black upright forked scales and a few black bristles in front. Palpi brown with deep brown scales, short, apical segment minute, penultimate large; proboscis rather thin, clothed with almost black scales and with scattered short pale hairs; antennae deep brown; clypeus reddish-brown.

Thorax brown, rich brown in some lights, brighter in certain lights than in others, clothed with bronzy brown narrow-curved scales and with long black lateral chaetae. Scutellum paler than the mesonotum, with narrow-curved bronzy brown scales and six posterior border-bristles to the mid lobe in two groups, a bare space between; metanotum deep brown; pleurae bright reddish-brown. Abdomen clothed with violet-black scales and with small basal lateral white patches; posterior border-bristles pale, of two sizes. Legs unbanded, deep brown; coxae, base and venter of femora reddish-brown. Ungues all small, equal and simple.

Wings not quite reaching the apex of the abdomen, with brown scales, costa darker; fork-cells of moderate length, the first sub-marginal longer but no narrower than the second posterior cell, its base nearer the base of the wing than that of the second posterior cell; its stem from one-third to one-half the length of the cell; stem of the second posterior not quite as long as the cell; posterior cross vein about one and a half times its own length distant from the mid cross-vein which unites with the supernumerary; scales on the first longitudinal, and on the branches of the second and fourth and on the third rather broad and dense, some long lateral narrow ones on the base of the second, fourth and upper branch of the fifth. Halteres with pale stems and black knobs.

Length, 4 millim.

Hab.—New Amsterdam (Dr. Rowland).

Time of capture, July.

Described from three females. One taken in a house in the morning, the others bred from larvae found in a hollow tree trunk at the side of a pond in Stanley Town, New Amsterdam.

Two specimens show the head scales darker than in the type.

Genus **Reedomyia,** Ludlow.

Canad. Ento., 1905, vol. xxxvii, p. 94.

Reedomyia niveoscutella, n. sp.

Pl. III, fig. 5.

Head ochreous brown; proboscis fawn coloured, dusky at the tip. Thorax with dull golden scales with two dull brown median bare lines; scutellum with flat silvery white scales looking like three silvery spots; plurae pallid with three patches of white scales. Abdomen deep brown with indistinct basal grey bands. Legs unbanded.

Female.—Head ochreous brown, clothed with pale creamy narrow curved scales, paler around the eyes, with narrow ochreous upright forked scales in front and broader dusky ones behind, the sides with ochreous flat scales.

Proboscis fawn coloured, slightly dusky at the tip. Palpi thin, testaceous with irregular dusky scales. Clypeus fawn coloured. Antennae brown, testaceous at the base, with a few small flat dusky scales on the last two segments. Thorax brown, clothed with narrow-curved rather dull pale golden scales and with golden brown and brown bristles; scutellum pale ochreous, clothed with small flat silvery white scales (in some lights they appear dull grey), border-bristles brown, six large and four small ones posteriorly to the mid lobe; metanotum brown, with grey tomentum; pleurae very pale ochreous with three irregular patches of grey scales.

Abdomen deep brown with dull violet reflections, the segments with narrow basal creamy bands and traces of pale scales apically and pallid border-bristles; lobes of female genitalia dark, prominent and acuminate.

Legs unbanded, brown, with coppery reflections; coxae and base and venter of femora pallid; fore and mid ungues equal and uniserrated.

Wings with rather short, fork cells; the first sub-marginal much longer and slightly narrower than the second posterior cell, its stem nearly equal to the length of the cell; stem of the second posterior as long as the cell, posterior cross-vein rather more than its own length distant from the mid cross-vein. Halteres pallid.

Length, 4.5 millim.

Hab. -India (Capt. James, I.M.S.).

Described from a perfect female. In general appearance it resembles a typical *Culex* of the *pipiens* group. It is closely allied to *Reedomyia pampangensis* (Ludlow), found at Angeles, Pampanga, Luzon, Phillippine Islands, but can at once be told by the uniform coloured thorax, which in *pampangensis* is ornamented with pale yellow and dark bronzy brown scales and slightly different venation. The flat white scales of the scutellum in both species are very marked.

Genus **Pecomyia,** nov. gen.

Head clothed with narrow-curved scales, upright forked scales and flat lateral ones; palpi in female short. Thorax with narrow curved scales; scutellum with narrow-curved and small flat scales mixed together on the mid lobe; narrow, rather long flat scales and a few narrow-curved ones to the lateral lobes; metanotum nude. Wings with mottled scales; the median vein scales large, bluntly Taeniarhynchus-shape, black and grey in patches, the lateral vein scales linear, but straight and stiff, arising in definte order on each side of most of the veins, like the teeth of a comb.

This genus resembles in general appearance *Grabhamia*, but can at once be told by the scutellar ornamentation and the straight stiff lateral vein scales.

It is a Culicine, and comes between *Reedomyia* and *Grabhamia*.

Pecomyia maculata, n. sp.

Pl. IV, fig. 7.

Head brown, with dull greyish and ochreous scales; proboscis ochreous, mottled with black scales, black at the apex; palpi ochreous, mottled with black scales.

Thorax brown, clothed with dull grey and dull golden-brown scales, paler behind and with traces of linear ornamentation; scutellum with grey scales.

Abdomen deep brown, with basal white bands. Wings mottled with brown and grey scales; halteres very pale ochreous. Legs ochreous, mottled with deep brown scales, tarsi dark brown, some of the segments with basal pale bands.

Female.—Head brown, densely clothed with dull grey narrow curved scales, with some similar shaped ochreous ones in front, dark brown upright forked scales, flat dark brown, then white lateral ones, and with deep brown bristles projecting forward over the eyes. Palpi deep ochreous, with blackish scales, tips of the apical segment grey; proboscis ochreous, with scattered deep brown scales, so dense at the apex that it is quite black; antennae brown, with narrow pale bands at the junction of the segments. Thorax deep brown, clothed with grey and dull golden brown narrow-curved scales, becoming almost white in front of the scutellum, traces of linear ornamentation seen in some lights, bristles deep brown; scutellum deep brown, the mid lobe with grey, almost white, narrow-curved scales, and a few small flat ones mixed with them; lateral lobes with rather narrow flat white scales, and a few narrow-curved ones at the edges; border-bristles rich brown; metanotum deep brown.

Abdomen deep brown with dull violet reflections and white basal bands, basal segment with grey scales and very pallid bristles; border-bristles pallid.

Legs ochreous with scattered black, grey and ochreous scales, apex of femora, tibiae and tarsi mostly dark scaled, the metatarsi with white basal bands, also the first two tarsals of fore and mid legs and all those of the hind pair; fore and mid ungues uniserrated; hind simple, all equal.

Wings with mottled brown and grey scales; most of the vein scales broad and truncated, all the median ones are so; the first, third, apical portions of fourth and fifth with thin straight lateral scales uniformly disposed; fork-cells short, first sub-marginal longer and narrower than the second posterior, their bases about level, stem of the first sub-marginal nearly two-thirds the length of the cell, stem of the second posterior as long as the cell; posterior cross-vein about its own length distant from the mid. Halteres very pale ochreous.

Length, 4.8 millim.

Hab.—India (James).

A very obscure species until examined microscopically, when the squamose characters of the scutellum and wings at once show that it is not a *Grabhamia*, which it superficially resembles.

Genus **Grabhamia**, Theobald.

Mono. Culicid., 1903, iii, p. 243.

Grabhamia ochracea, n. sp.

Head tawny, with yellowish-grey scales; proboscis with an ochreous band in the middle, black apically, brown basally. Thorax ornamented with bright ochreous brown and silvery grey scales, the ochreous area forming two more or less distinct dusky spots in front, and others close to them, also two spots in front of the wings. Abdomen bright golden ochreous, with traces of a dark band on the fourth segment and two dark spots on the apical segment. Legs pale ochreous, the tarsi darkened except at their bases and apices. Wings with brown scales and some scattered ochreous ones, especially along the base of the costa, where they form a more or less distinct pale line.

Female.—Head clothed with pale yellowish-grey narrow-curved scales, ochreous upright forked scales in the middle, brown ones at the sides, with numerous pale golden and brownish bristles projecting forwards; palpi with mottled brown and ochreous scales, the latter most prominent on their upper surface; clypeus tawny; proboscis clothed with black scales apically, rich ochreous ones in the middle, and mixed ochreous and dusky ones basally, thus giving a distinctly banded appearance. Antennae brown, ochreous basally. Thorax ochreous brown, clothed with narrow-curved rich ochreous brown and silvery grey scales, arranged as follows:—Two spot-like areas of rich ochreous brown scales in front, others behind in conjunction with a patch of dusky ones just in front of the root of the wings, the silvery grey ones fitting in between; bristles brown and golden; scutellum pale, with pale narrow-curved scales and a few dusky ones at the base of the mid lobe, border-bristles golden brown, eight to the mid lobe; metanotum pale brown; pleurae ochreous-grey and pale brown, with patches of small flat grey scales. Abdomen completely clothed with bright golden-ochreous scales, except for a median patch of dusky ones on the fourth and two spots on the apical segment, with traces of pale scales at the base of the latter and sides of the preceding, hairs bright golden yellow.

Legs pale ochreous, femora with scattered dusky scales at the apex, also at the base and apex of the tibiae, first and second tarsals dusky in the middle, pale at each end, third tarsal pale at the base, dusky apically, fourth tarsal deep brown; ungues equal and simple.

Wings with brown scales, the costa and first long vein mottled with pale ochreous; third and fifth long veins very dark scaled; first sub-marginal cell longer and narrower than the second posterior, their bases nearly level, stem of the former a little more than half the length of the cell, stem of the latter about two-thirds the length of the cell;

posterior cross-vein nearly three times its own length distant from the mid; scales on the base of the costa pale ochreous, and many along its upper part, also many pale scales on the first long vein, and a few seen in certain lights on the other veins. Halteres pale ochreous.

Length, 5.5 millim.

Hab.—India (Dr. Christopher).

Distinct from all other Grabhamias by its very marked golden ochreous abdomen. Described from two perfect females.

Genus **Culicida**, Felt.

Mosquitoes or Culicidae, N.Y. State, App., 1904, p. 391[b].

Head, thorax and abdomen with similar scales to *Culex*. Wings with short fork-cells and clothed with denser and larger vein scales than *Culex*, the median vein scales especially so. The palpi of the female longer than in *Culex*. The stem of the first sub-marginal cell is usually short, but may be a little longer or a little shorter than the cell.

The genus can at once be separated from *Culex* by the short fork-cells and the scale structure of the wings.

The characters given by Felt will not all hold even in the same species. For instance, "the posterior cross-vein about its own length from the mid cross-vein" is given as a generic character in the female; in *C. cantans*, Meigen, it varies to as much as its whole length; and in the male, again Felt says "the petiole of the first fork-cell is equal in length to that of the cell"; it in reality will vary not only in the same species but in specimens from the same batch of eggs. The type of this genus should be Meigen's *cantans*, certainly not my *Culex canadensis*, which was founded long after the former species.

The larvae in this genus have short thick syphons.

A number of other species come in it as *cantator*, Coq., *nigripes*, Zett., *nemorosus*, Meigen, *morsitans*, Theob., *diversus*, Theob., *annulipes*, Meigen, *vexans*, Meigen, and *flavescens*, Fabricius.

Felt gives the following American species, which, judging from the wings, fit in here, namely, *fitchii*, Felt, *cinereoboreali*s, Felt, *onondagensis*, Felt, *absarratus*, Felt, and *lagarensis*, Felt. Others he refers to that certainly do not belong here are *squamiger*, Coq., *triseriatus*, Say, *trivittatus*, Coq., *atropalpus*, Coq., and *sollicitans*, Walker.

Culicada bupengaryensis, n. sp.

Pl. III, fig. 4; Pl. IV, figs. 1-3.

Head deep brown with dull golden scales, palpi and proboscis deep brown, basal segments of antennae bright ferruginous. Thorax deep brownish black, clothed with bright golden scales, with two median parallel bare lines. Abdomen deep brown with violet reflec-

tions, unbanded, but with basal lateral creamy-white spots. Legs deep brown, unbanded, base and venter of femora pale reddish-brown. Wings with short fork-cells.

Female.—Head deep brown, clothed with long narrow-curved pale golden scales and flat yellowish ones laterally, upright forked scales ochreous; palpi and proboscis brown; clypeus bright brown, with a median sulcus and a blunt process on each side towards the base; the palpi are clothed with almost black scales and bristles, the apical segment minute, the penultimate long. Antennae brown, basal segments bright testaceous. Eyes black and silvery. Thorax deep brownish black, clothed with irregularly disposed golden narrow curved scales except on two median parallel lines, which show as two dark lines on the golden scaled mesonotum, and which are ornamented with narrow-curved bronzy-black scales, a few of these also occur over the roots of the wings; bristles partly black, partly golden. Scutellum ochreous brown, with pale golden narrow-curved scales, the mid lobe with deep brown and golden border-bristles, the lateral with deep brown ones only; metanotum brown and testaceous; pleurae testaceous and brown, with flat creamy scales.

Abdomen deep brown in some lights, with violet reflections in others, the segments with basal lateral creamy patches, the basal segment testaceous, with two patches of dark scales; posterior border-bristles bright reddish-brown. Venter with yellowish basal bands. Legs brown, with metallic violet and coppery hues, bases and venter of the femora ochreous; fore and mid ungues equal, uniserrated, thick, hind equal and simple, straighter than the others.

Wings with short fork-cells, first sub-marginal a little longer and narrower than the second posterior, their bases nearly level, its stem not quite so long as the cell, stem of the second-posterior as long as the cell, posterior cross-vein about its own length distant from the mid, which is longer than the posterior; scales brown.

Halteres with pale stem, fuscous knob with creamy scales.

Length, 5.2 to 5.5 millim.

Male.—Palpi deep brown, hair-tufts deep brown; antennae with deep brown plume-hairs. Head and thorax as in the female; prothoracic lobes prominent. Abdomen as in the female, but the basal parts of the segments are unscaled and testaceous, giving a broadly banded appearance. The first sub-marginal cell is only about half the width of the second posterior cell and about the same length, its stem the same length as the cell, whilst that of the second posterior is shorter.

Ungues of fore legs curved unequal, the larger uniserrated, the smaller simple; in the mid more unequal than the fore, the smaller curved and uniserrated, the larger simple, bent close to the base, then

nearly straight; hind pair equal, simple, small and nearly straight, acuminate. Male genitalia with prominent claspers (*vide* figure 3, Pl. iv).

Length, 5. to 5.5 millim.

Hab.—Bupengary, South Queensland (Dr. Bancroft).

Time of capture, November.

Described from a series of males and females collected by Dr. Bancroft. It is the only known Australian species with similar abdomen, and cannot be confused with any other species. The male ungues are very marked. It clearly comes in Felt's new genus *Culicada*.

Genus **Culex**, Linn.

Culex simpsoni, n. sp.

Pl. IV, figs. 10, 10a.

Head pale ochreous in the middle, a dark area on each side and pale laterally. Proboscis brown; dark brown and swollen apically.

Thorax clothed with dull pale ochreous and reddish-brown scales, giving a mottled appearance, with two bare median parallel lines. The ornamentation consists of two reddish-brown spots in front, two long lateral and one long median one behind. Abdomen blackish, with basal white bands. Legs deep brown, with pale apical femoral and tibial spots. Ungues of female equal and simple, the fore and mid of the male unequal and uniserrated.

Female.—Head deep brown, clothed with narrow-curved pale scales and with small flat white ones laterally, in the middle are ochreous upright forked scales, at the sides numerous black upright forked scales, giving the appearance of two black patches when viewed with a hand lens. Clypeus brown. Proboscis brown and swollen apically, where it is darkened. Palpi deep brown. Antennae brown, basal segment pale fawn coloured, slightly darker on the inner side.

Thorax deep brown, clothed with narrow-curved pale ochreous scales, with two roundish patches of a rusty red hue in front, and three longer patches behind, often somewhat indistinct in outline, and giving a somewhat mottled appearance. When distinct the lateral hind patches are elongate and curved on the inner border, and the median one is broad and long. In front arise two nearly parallel dark median bare lines, broadest anteriorly, and which disappear about the middle of the mesonotum; chaetae pale brown; scutellum with narrow-curved pale scales and six dark border-bristles to the mid lobe; pleurae pale greyish-brown, with some patches of flat white scales. Abdomen deep brown, with basal white curved bands not extending quite across the segments; posterior border-bristles brown; apex rather hirsute.

Legs deep brown except the bases and venter of femora, which are pale ochreous, apices of femora and tibiae with a pale spot, most

prominent on the hind tibiae, bristles of tibiae bright brown, of metatarsi black; ungues small, equal and simple.

Wings with the first sub-marginal cell considerably longer and narrower than the second posterior cell, its base nearer the base of the wing, its stem rather more than one-half the length of the cell, stem of the second posterior cell as long as the cell; posterior cross-vein about twice its own length distant from the mid cross vein. Halteres with pale stem and dusky knob.

Length, 3.5 to 4.5 millim.

Male.—Palpi black, with a narrow pale band towards the base, rather acuminate; last two segments and apex of the antepenultimate segment with scanty black hairs. Antennae with brown hairs, nodes black, internodes grey. Legs and abdomen as in the female. Fore and mid ungues unequal, the larger with a large outstanding tooth, the smaller with a short acute basal tooth; the hind claws small, curved, equal and simple.

Genitalia with long curved claspers, with small dark terminal segment, and a prominent bunch of long flat sword-like bristles, four in number, arising from a prominence on the basal lobe, three much longer than the fourth; the three long ones are curved at their apices, near this tuft is a single leaf like plate, pointed apically, the three long spines are not as long as the claspers.

Length, 3.5 to 4.5 millim.

Hab.—Transvaal.

Apparently very common. Very variable in size. Its chief gross characters are the thoracic ornamentation and the pale apical femoral and tibial spots. The thoracic ornamentation is not always distinct. In some the markings of rust red are very clear, two roundish ones in front, and two prominent lateral elongated ones behind, and a median long broad one. The female palpi are composed of three segments, the apical one very large, longer than the two basal ones, the basal the smallest.

The male genitalia are very characteristic, the bunch of flat bristles on the basal lobe being most marked, three being long and one short.

Culex bostocki, n. sp.

Head deep brown, with scattered golden scales; proboscis and palpi black, the former longer than the body. Thorax rich brown with brown scales, and some scattered dull golden ones forming two indistinct lateral lines; scutellum with pale scales. Abdomen black, the basal segments with narrow pale apical bands, and all the segments with pale lateral apical spots. Legs deep brown, except base and venter of femora and knee spots, which are pale.

Female.—Head deep brown, with pale narrow-curved scales and

long black upright forked scales, sides with small flat pale ochreous scales, and a narrow border of curved grey scales around the eyes. Proboscis long and thin, black. Palpi black. Clypeus black.

Thorax deep brown, clothed with narrow-curved brown scales and some scattered dull golden ones, which form two more or less distinct lines, which pass down to the front of the roots of the wing, and which spread across between the wings and around the bare space in front of the scutellum; on the denuded surface are seen two dark median parallel lines, which shine through the scales (when held in some lights the dark lines become pale silvery grey). Scutellum with narrow curved pale yellowish scales and black border-bristles, seven of the latter to the mid lobe. Metanotum brown. Pleurae brown, with some small flat white scales. Abdomen black, the second and third segments with traces of pale scaled apical borders, and all the segments with grey apical lateral spots; venter with grey apical bands, the basal segments with many scattered white scales; border-bristles pale ochreous, the two last segments with many pale hairs over their whole surface.

Legs deep brown except the base and most of the venter of the femora; knee spots yellowish, and a trace of a pale spot on the apex of the tibiae; hairs on femora, tibiae and metatarsi pallid; hind metatarsi about one-fifth longer than the hind tibiae. Ungues all equal and simple, very small.

Wings with the first sub-marginal cell longer and just a little narrower than the second posterior cell, its base nearer the base of the wing than that of the second posterior cell, its stem rather more than one-half its length; stem of the second posterior cell not quite as long as the cell; posterior cross-vein long, about its own length distant from the mid cross-vein.

Halteres with pale stem and dusky knob, clothed with dull grey scales.

Length, 4 millim.

Hab.—Transvaal (Simpson).

Described from a single male. Easily told by the apical abdominal banding and lateral apical white spots.

Culex minutus, n. sp.

Pl. IV, figs. 9, 9a.

Thorax with golden scales, looking deeper reddish-brown at the sides, with three parallel dark lines, metanotum pallid. Abdomen blackish-brown, with dull grey irregular basal bands and white lateral spots extending along nearly the whole length of the segments. Legs deep brown, with traces of small dull apical spots on femora and tibiae. Five spines on prominence of male gentalia, three being as long as the claspers.

Female.—Head clothed with narrow-curved pale creamy scales and numerous black upright forked scales, and small flat grey lateral ones.

Proboscis, palpi and antennae deep brown. Clypeus black, elongated. Thorax deep brown, clothed with pale dull golden narrow curved scales, in some lights appearing dark (reddish-brown) at the sides, and with three parallel dark bare lines, scales paler before the scutellum; scutellum greyish brown, with narrow-curved pale golden scales; metanotum pale greyish; pleurae grey.

Abdomen deep brown, with irregular indistinct grey basal bands and large white lateral spots, which seem to extend the greater length of some of the segments; posterior border-bristles long and pallid.

Legs deep brown, venter of femora pale, traces of pale spots at the apices of femora and tibiae; ungues small, equal and simple.

Wings with the first sub-marginal cell considerably longer and a little narrower than the second posterior cell, its base nearer the base of the wing, its stem less than one-fourth the length of the cell, stem of the second posterior cell about two-thirds the length of the cell; *posterior cross-vein much* longer than the mid cross-vein, about one and a half times its own length distant from the mid.

Halteres with pale stems, and large rather dusky knob.

Length, 2.8 to 3 millim.

Male.—Similar to female. Palpi brown; acuminate; last two segments deeper brown with brown plume hairs; the two apical segments nearly equal. Fore ungues unequal but not so much so as is usual in *Culex*, the larger with a large tooth, the smaller with a small acute tooth near the base, mid ungues more curved than the fore, both uniserrated, hind equal and simple. Genitalia with the claspers curved, with a membranous expansion at one side and a small terminal segment, on the basal lobe is a prominence with a tuft of three large broad acute spines and two small ones, and at the side of the prominence a blade like plate, rounded apically, and two small spines arising from a common base.

Length, 2.5 to 3 millim.

Hab.—Transvaal (Simpson).

Closely related to *Culex simpsoni*, but differs in the male genitalia, in which the foliate plate is rounded apically, not acute, and in the three long flat spines being acute, not curved at their apices, and in their being as long as, not shorter than, the claspers.

Culex bifoliata, n. sp.

Pl. IV, fig. 11.

Head brown, with dull yellowish scales in the middle, a black patch on each side, and grey laterally. Male palpi deep brown, with

a narrow pale band at the base of each of the two apical segments, and a broader pale one on the antepenultimate segment. Proboscis unbanded. Thorax deep brown, with paler scales at the sides in front. Abdomen brown, with traces of pale grey basal banding. Legs brown, with very narrow pale bands, involving both sides of the joints. Fore and mid ungues unequal, uniserrate, hind equal and simple. Male genitalia with two leaf-like plates (Pl. iv, fig. 2).

This species closely resembles *Culex hirsutipalpis*, but is smaller and the male genitalia differs, there being two leaf-like plates to each side, as shown in the figure. The male only so far is known.

Length, 3 millim.

Hab.—Transvaal (Simpson).

Very marked, and separated easily by the genitalia.

Culex pallidothorax, n. sp.

Head and thorax uniformly pale fawn coloured, the latter with two indistinct median darker lines in front; proboscis dark brown apically, paler basally; pleurae very pale. Abdomen deep brown, with basal pale creamy bands. Legs uniformly brown, paler at their bases. Male palpi dark brown, unbanded.

Female.—Head deep brown, clothed with pale narrow-curved scales, brown and dull ochreous upright forked scales and small flat grey lateral scales. Palpi narrow, deep brown; proboscis deep brown apically, paler towards the base; clypeus deep brown; antennae brown, with narrow grey bands.

Thorax brown, densely clothed with narrow-curved dull pale scales, giving it a general uniform pale fawn coloured appearance, bristles apparently absent on the dorsum, brown ones laterally, traces of two dusky median lines seen in some lights; scutellum of similar colour to mesothorax, with eight long brown posterior border-bristles spread out fan-like, and with long pale narrow-curved scales projecting between; metanotum brown; pleurae very pale grey.

Abdomen deep brown, with narrow basal pale bands and many pale scales on the last segment and on the apical border of the penultimate, border-bristles pale brown.

Legs uniformly brown, base and venter of femora pale, a pale spot on the apex of the hind femora; ungues equal and simple.

Wings with the fork-cells of nearly equal length, the base of the second posterior, if anything, slightly nearer the base of the wing; stem of the first sub-marginal slightly more than half the length of the cell, stem of the second posterior more than half the length of the cell; posterior cross-vein about one and a half times its own length distant from the mid cross-vein, the sixth vein very close to the fifth; halteres ochreous.

Length, 5.5 to 5.8 millim.

Male.—Resembles female in general appearance, but the flat scales at the sides of the head spread rather further on to the crown; palpi deep brown, acuminate, apical segment a little longer than the penultimate, both deep brown, with deep brown hair-tufts, traces of a very narrow pale band towards the base of each palp. Fore and mid ungues unequal, the larger uniserrate, the smaller simple, mid equal and simple.

Apical segment of abdomen with all pale ochreous scales.

Length, 5.8 millim.

Hab.—India (James).

Somewhat resembling *Culex fatigans*, Wied., but easily told by the more uniform fawn coloured thorax, and the longer, thinner female palpi, and by the long narrow-curved scales on the border of the scutellum.

Culex similis, Theobald.

Mono. Culicid., 1903, iii, p. 207. (Female.)

Male.—Head as in the female, but narrower; palpi brown, the two apical segments very dark, about equal in length, apical segment acuminate, both with long black hair-tufts, a trace of narrow pale basal banding on the penultimate, and another narrow pale band towards the base, apex of the antepenultimate segment hairy on one side; palpi longer than the proboscis by nearly the whole of the two apical segments. Proboscis dark brown, contracted towards the base. Antennae banded brown and grey, with rich brown plume-hairs. Thorax as in the female, but the pale scutellum has nine median posterior border-bristles, and the scales are pale golden; metanotum pale ochreous.

Abdomen very hairy, hairs pale golden brown, banded as in the female. Legs as in the female; fore and mid ungues unequal, uniserrated, hind equal, small, simple.

Length, 5.5 millim.

Hab.—New Amsterdam, British Guiana (Dr. Rowland).

Time of capture, July.

Described from a specimen bred with females from larvae taken in the trunk of a hollow tree at the side of a pond in Stanley Town. The female's are quite normal.

Genus **Pseudouranotaenia,** nov. gen.

Head clothed with flat scales and with a few upright forked ones; proboscis long, nearly as long as the whole body, swollen apically, and hairy in the female, not so long in the male. Antennae pilose in the female, plumose in the male; palpi very small in both sexes.

Thorax clothed with narrow-curved scales and a series of flat outwardly projecting scales at the sides of the dorsum; scutellum with very small flat scales on the mid lobe; metanotum nude; pleurae with some flat scales. Abdomen and legs normal. Wings ornamented; venation much as in the *Mimomyia*, for-cells in female both small, the first sub-marginal smaller than the second posterior, but not so much so as in *Uranotaenia;* wing scales of *Uranotaenia* type except that there are patches of flat scales on the wing field similar to those at the base of the wing seen in *Uranotaenia*. Fork-cells in male very similar to the female, but the upper branch of the first sub-marginal has a few very large scales only. Prothoracic lobes with flat scales. Fore ungues of male nearly equal and simple; the mid unequal.

This genus is allied on the one hand to *Uranotaenia*, and on the other to *Mimomyia*. The thoracic curved scales resemble those of *Mimomyia*, and also the fork-cells, but the wing scales differ considerably.

Pseudouranotaenia rowlandii, n. sp.

Pl. IV, figs. 4 and 6.

Head very pale blue; proboscis as long as the whole body in the female, shorter in the male, brownish-black; palpi and antennae brown. Thorax brown, with bronzy curved scales and a blue line of flat scales on each side; scutellum brown, with bronzy flat scales. Abdomen deep brown, unbanded and unspotted. Legs deep bronzy brown. Wings ornamented with black and white.

Female.—Head with occiput large, covered with flat pale blue scales and some black bristles; proboscis deep brown, testaceous at the tip, swelling apically, slightly hairy, nearly as long as the whole body; palpi very small, deep brown; antennae pilose brown.

Thorax brown, with bronzy narrow-curved scales, which have a narrow golden border; on each side, before, and running up to, the base of the wings is a line of pale blue flat scales pointing outwards (in some lights they appear almost white); bristles black; scutellum deep ochreous brown, the mid lobe with small flat violet-brown scales, the lateral lobes with them more pointed and larger; posterior border-bristles of mid lobe four in number; metanotum deep brown; pleurae brown and ochreous, with some patches of flat white scales.

Abdomen clothed with deep blackish-brown scales, slightly paler below; posterior border-bristles pale golden.

Legs deep brown except the coxae and venter of femora, which are paler brown to ochreous; the femora, especially those of the mid legs swollen basally, the apex of femora, and to some extent the tibiae with the scales outstanding giving the appearance of apical tufts which are most prominent on the hind legs; ungues small, equal and simple.

Wings ornamented with black, creamy and white, the silvery white forming a large spot on the dark costal border, at the regions of the cross-veins and at the base of the fifth long vein, the silvery white scales are large and spatulate, and form a mass at the base of the third long vein, and from thence up to the costa to form the costal spot; there are also a few white scales on the branches of the second long vein, the apex of the third and the apex of the lower branch of the fourth, another patch at the base of each branch of the fifth, its base with a long line of large flat white to mauve scales, and also the basal part of the sixth; there are also large flat white or mauve scales forming a smaller patch at the base of the fourth vein.

The lateral scales on the second, third and fourth veins large and spindle-shaped, the dark median scales spatulate and narrow; the smallest of the series of fringe scales clavate; first fork-cell not quite as long and much narrower than the second posterior cell; its base nearer the apex of the wing; its stem about two and a half times the length of the cell, stem of the second posterior cell about one and a fourth times the length of the cell; posterior cross-vein longer than the mid, nearly twice its own length distant from it. Halteres with pale stem and fuscous knob.

Length, 3 millim.

Male.—Head much as in the female, but with a few short black upright forked scales, forming a triangular patch with the base along the nape; antennae plumose, plume hairs deep brown, internodes grey, palpi very minute, brown with grey sheen at the apices; proboscis deep brown, much swollen apically, and with numerous dark bristles and hairs. Thorax as in the female; prothoracic lobes, with flat grey and pale blue scales.

Legs as in the female, but the mid pair have denser scales at the apices; ungues of fore legs small, nearly equal and simple, rather broad, and those of the hind legs equal; those of the mid unequal, simple, one large, curved rather irregularly, the last segment of the hind legs with distinct broad spines.

Scales on the wings somewhat similar in arrangement to female, but there is a distinct double row of large white scales along the base of the fifth long vein, and a few large ones only along the upper branch of the second long vein; the remainder very similar.

Length, 3 millim.

Time of capture, July.

Hab.—Stanley Town, New Amsterdam, British Guiana (Dr. Rowland).

Described from a perfect male and female. It forms a very marked species, the ornamented wings and marked head and thoracic adornment at once separating it from any other mosquito that I

know of. The colour of the head and thoracic markings varies according to the light, especially under the microscope; in some lights the scales show blue, in others almost silvery white. The same applies to the pale scales on the wings. The large scales forming the larger patch of white become so transparent in a balsam preparation that it is difficult to detect them at all.

I cannot be certain of the mid ungues of the male, the large curved one is very marked, but I cannot make out clearly a second claw.

EXPLANATION OF PLATES III. AND IV.

Illustrating Mr. Fred V. Theobald's paper on "New *Culicidae*."

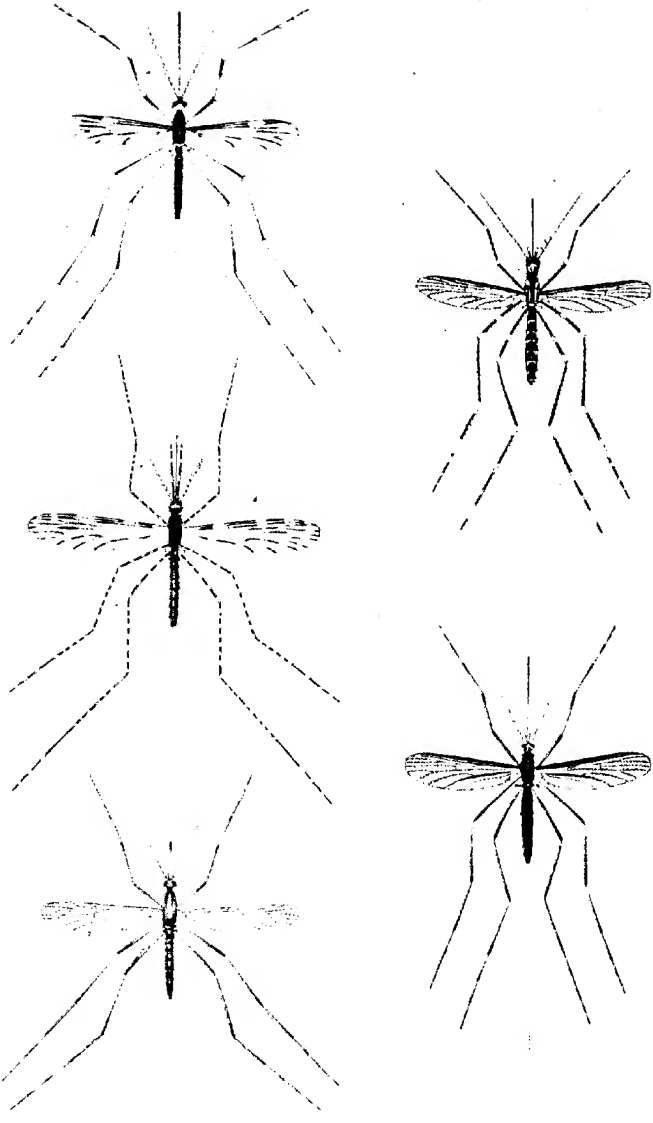
PLATE III.

Fig. 1.—*Pseudouranotaenia rowlandi*, n.sp. Female.
Fig. 2.—*Stegomyia poweri*, n.sp. Female.
Fig. 3.—*Pyretophorus ardensis*, n.sp. Female.
Fig. 4.—*Culicada bupengaryensis*, n.sp. Female.
Fig. 5.—*Reedomyia niveoscutella*, n.sp. Female.

PLATE IV.

Fig. 1.—*Culicada bupengaryensis*, n.sp. Male ungues. *a* fore, *b* mid and *c* hind claws.
Fig. 2.—*Culicada bupengaryensis*, n.sp. Female ungues.
Fig. 3.—*Culicada bupengaryensis*, n.sp. Male genitalia.
Fig. 4.—*Pseudourantaenia rowlandi*, n.sp. Mid ungues and tarsal segment.
Fig. 5.—*Culicada bupengaryensis*. Female (palp of).
Fig. 6.—*Pseudouranotaenia rowlandi*, n.sp. Wing of male.*
Fig. 7.—*Pecomyia maculata*, n.sp. Wing of female.
Fig. 8.—*Gnophodcomyia inornata*, n.sp. Wing of female.
Fig. 9.—*Culex minutus*, n.sp. Male genital prominence.
Fig. 9a.—*Culex minutus*, n.sp. Clasper.
Fig. 10.—*Culex simpsoni*, n.sp. Male genital prominence.
Fig. 10a.—*Culex simpsoni*, n.sp. Clasper.
Fig. 11. *Culex bifoliata*. Male genital prominence.
Fig. 12.—*Culex hirsutipalpis*, Theobald. Male genital prominence.
Fig. 12a.—*Culex hirsutipalpis*. Terminal segment of clasper.

* The first fork-cell is drawn too wide and long.



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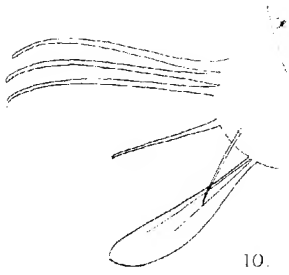

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JLICIDAE

REVIEWS AND CURRENT LITERATURE.

Beiträge zur physiologischen Anatomie der Pilzgallen.—By Hermann Ritter von Guttenberg. Pp. 70, with 4 plts. Leipzig: Wilhelm Engelmann, 1905.

A careful study of this interesting little work cannot fail to arrest the attention of the biologist as well as the mycologist. We know so very little as to the inter-relations and inter-reactions between galls and the host plants, that one's only regret is that the author has not written at greater length on many of the issues raised. There is yet a wide field of research for the physiological botanist.

In some detail the effects brought about by five different fungi upon their host plants are described, and the anatomical changes which occur in the tissues. The fungi treated of are *Albugo*, *Exoascus*, *Ustilago*, *Puccinia*, and *Exobasidium*.

According to the author the host is dominated by or subservient to the parasite. A number of histological and cytological problems are touched upon and some discussed, the conclusions arrived at, however, do not always appear convincing. The book is none the less interesting, and to a certain extent presents the subject in a somewhat fresh light, with the physiological side ever to the fore. Dr. Guttenberg has certainly produced a work full of suggestion, and one which cannot fail to attract the attention of all interested in this important field of research.

W. E. C.

British Fisheries, their Administration and their Problems.—By James Johnstone. Pp. xxxi + 350, 1 pl. London: Williams and Norgate, 1905.

Amongst the numerous students of the British Fisheries there are few who have given any serious attention to the economic side, indeed much of the work that has been published during recent years, as the result of investigations at the different marine stations, shows evidence that the workers are not acquainted with this side, and in consequence the work to a certain extent suffers. To such Mr. Johnstone's well-printed work will be very welcome.

The author divides his subject into two parts, in the first of which he gives an admirable review of the Fisheries from 1863 to the present day, tracing in a concise and interesting manner the development of modern legislation. There is also a chapter devoted to the research organisations in other countries.

The second part deals with Fisheries Problems, and includes a chapter on the life-history of fishes, in which the advances of our knowledge are dealt with in chronological order. Metabolism in the sea and hydro-

graphical investigations are the subjects of two further chapters, and able résumés are given of each. The chapters on fishery statistics, the impoverishment of the fishing grounds, the destruction of immature fish, and marine pisciculture, constitute, in our opinion, the most valuable portion of this work, and alone make it one of permanent interest and value. From a mine of official Reports the author has selected just the information we wanted.

Such a book as this has long been wanted, and the author has handled his subject in so able and interesting a manner that it will be readily sought after. All who have to do with the control of the Fisheries, whether they be those who expect "practical results" from the investigator in a very short time—and at a very cheap rate—or not, will, after a careful perusal of this work, agree with the author "that the only way to ensure that the fisheries may by and by be administered in the best interests of the fisherman and the consumer, is to persevere slowly and patiently with the acquirement of scientific facts," but the by and by, we fear, will be delayed until we have a competent Board of Fisheries distinct from that of Agriculture.

W. E. C.

Report on Economic Zoology for year ending April 1st, 1905.—By Fred V. Theobald. Pp. 1-123, 44 figs. London: Headley Bros., 1905.

Mr. Theobald's report is full of valuable information, treating of numerous farm and plant pests. Special mention must be made of an account of a new bee enemy, *Rhyphus fenestralis*, Scop., a new Aphid, *Siphonophora fragariella*, attacking strawberry plants, and the account of the Giant Willow Aphis, *Lachnus viminalis*, Fonsc.

W. E. C.

Insects and Fungi injurious to plants with remedial treatment.—By G. F. Strawson. Pp. xii. + 201, 69 figs. London: Spottiswoode and Co., Ltd. [1905].

In his preface the author states "wisely or unwisely, I have refrained from copying, or even looking into, the writings of others, except in a few instances." In treating of a subject so vast as expressed in the title of this little work, no one can afford to neglect or overlook the work of his fellow workers, and Mr. Strawson's book fails through this omission. On p. 190 he states that he has not made a special study of entomology, and we fear that the really valuable and interesting section on "Processes and Materials" will suffer on this account. Should a second edition be called for, the scientific names of the different insects, etc., should certainly be revised.

W. E. C.

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